Application Note

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Dual Controller Software Development for MPC561/MPC563 EVB

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1. Introduction

Technologies for complex high-end systems continue to drive demand for higher performance and I/O expansion. One potential solution to this increase in performance is the implementation of a dual processor system.

The configuration of a dual controller system would typically consist of a MPC563 as a master device with onboard flash and a MPC561 as a slave device.

The increase in hardware complexity for a dual processor system also results in an increase in the software development complexity.

This applications note is intended to describe an environment that minimises the software development complexity for a dual controller application. The environment for this dual processor configuration uses relocate-able code stored in the flash of the master device (MPC563) that runs on the slave device (MPC561).

The software environment detailed in this applications note was developed for the MPC561/2/3/4 Dual Controller EVB, using the Wind River Systems' DIAB C complier and linker.

For a hardware description refer to *Multi-controller Hardware Development for MPC5xx Family*, AN2667.

2. Functional Overview

The configuration of the Dual Controller EVB uses a MPC563 master device connected to a MPC561 slave device. The MPC563 master device has on chip flash memory that contains the master code and the re-locatable slave code. See Figure 1.

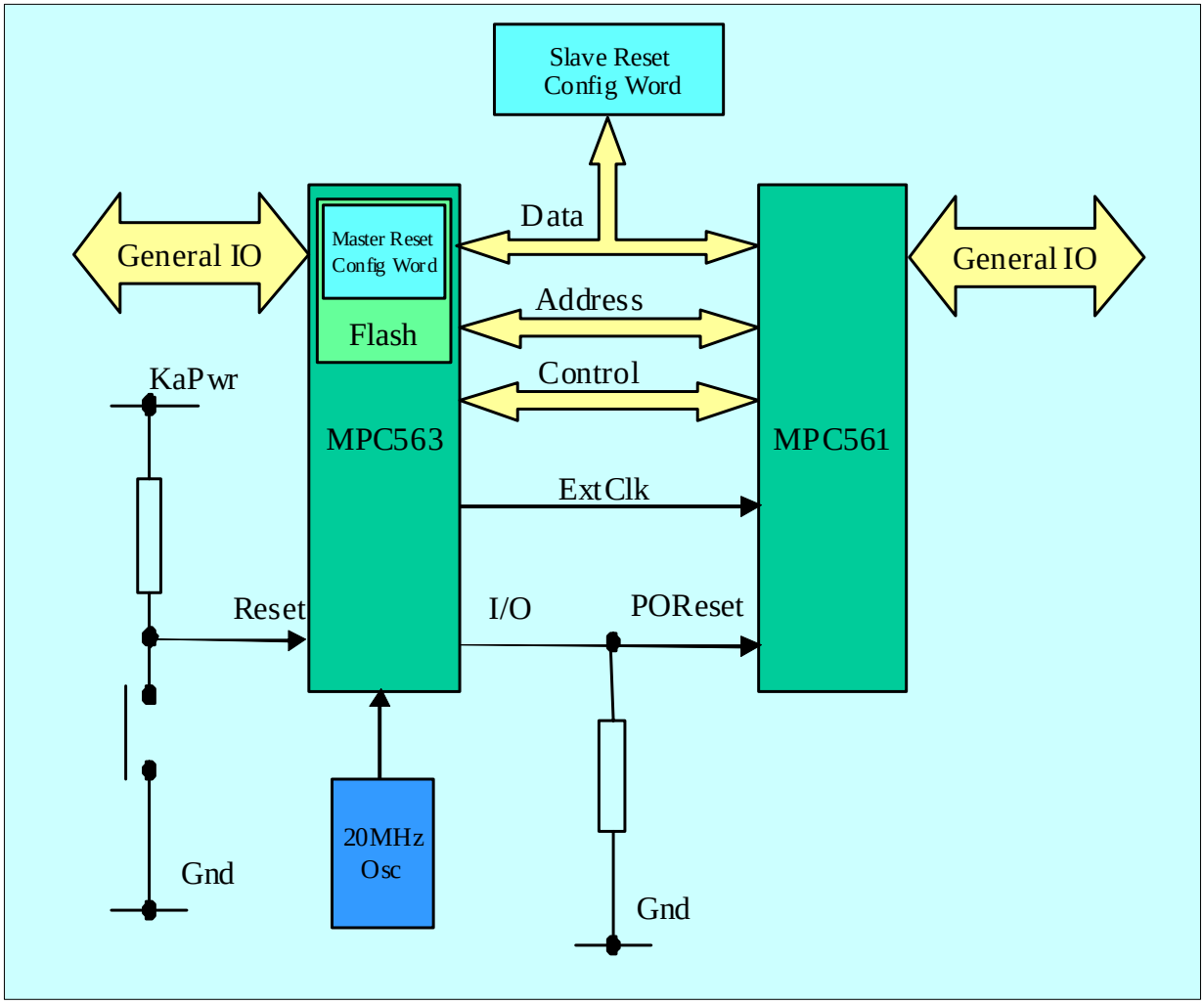

Figure 1

On system boot up the master device boots from its internal flash memory while holding the slave device in reset. The master device uses the internal flash reset configuration word (RCW) on system boot.

The master device releases the slave device from reset, which samples the reset configuration word (RCW) from the external data bus. The RCW is setup via dip-switches on the dual-controller EVB. The RCW is presented to the slave device on the data bus with use of external logic that monitors the slave poreset and sreset signals. Refer to *Dual MPC561/2/3/4 Autotemp Evaluation Board User's Manual*, MPC561AEVBUM/D for more detail on the hardware description.

The reset configuration word for the slave places the device in peripheral mode. In peripheral mode the master has access to the internal memory map of the slave. The master then configures the slave and loads the re-locatable code into the slave's CALRAM.

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The master releases the slave from peripheral mode into slave mode. The slave then executes the loaded code. In this configuration the slave does not have access to the master device.

The master executes it own code from its internal flash memory.

It is the advanced features of the linker that provide the ability to partition and relocate the code.

3. Detailed Description

3.1. Hardware Configuration

For a hardware description refer to *Multi-controller Hardware Development for MPC5xx Family*, AN2667.

The extclk input on the slave device is connected to the clkout pin of the master device. The modck[1:3] pins for the slave device are set to 0b100 which selects extclk pin as a 1:1 clock source for the slave. This enables the clock on slave device to synchronise to the clock on the master device.

Slave Device Configuration

The slave device reads the reset configuration word from the data bus, as the EXTCONF pin is pulled low.

The reset configuration word sets up the following conditions:

- Address Map (D28:30 = 0b001): Selects the slave device to reside at address 0x40000- 0x7FFFFF. This is the IMMR[ISB0:2 = 0b001] settings.
- Peripheral Mode (D16= 0b1): Allows the Master device to access the internal memory mapped address of the slave.
- External Arbitration(D0 = 0b1): Allows master device to control bus arbitration.
- Re-locatable Exception Table: The base address of the slave device is set to 0x400000 (IMMR[ISB0:2]=0b001) and the default location for the exception table is expected at address 0x400000 through 0x402000. However, the Slave MPC561 has no internal or external memory mapped to this address to store the exception table. Therefore the exception table has to be relocated into the slave internal CALRAM. This is achieved by setting the following bits:
- IP bit(D1 = 0b1) is required to be set.
- ETRE bit(D19 = 0b1). Exception Table Relocation Enable is set to enable the BBCMCR[OERC] bits.
- OERC bits (D24:25 =0b11). This sets the bits in the BBCMCR which relocates the Exception Table to the internal CALRAM at address 0x7FE000 for the slave device. Note that the exception table is a list of branch absolute commands set at double-word boundaries.

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Master Device Configuration

The master device uses the internal reset configuration word as UC3FCFG is erased (0x00000000). This RCW is selected as the active low bit UC3FCFG[HC](RCW:D20) is erased.

This sets the device to be master with internal memory space, mapped from 0x0000000 - 0x3FFFFFF (IMMR[ISB0:2] = 0b000) with internal bus arbitration enabled. The exception table for the master device is at address 0x00000000-0x00002000.

Reference the MPC561/MPC563 User Manual and for a more detailed description of the reset configuration word.

3.2. Single Processor Software

For single processor development the software structure is shown in Figure 2.

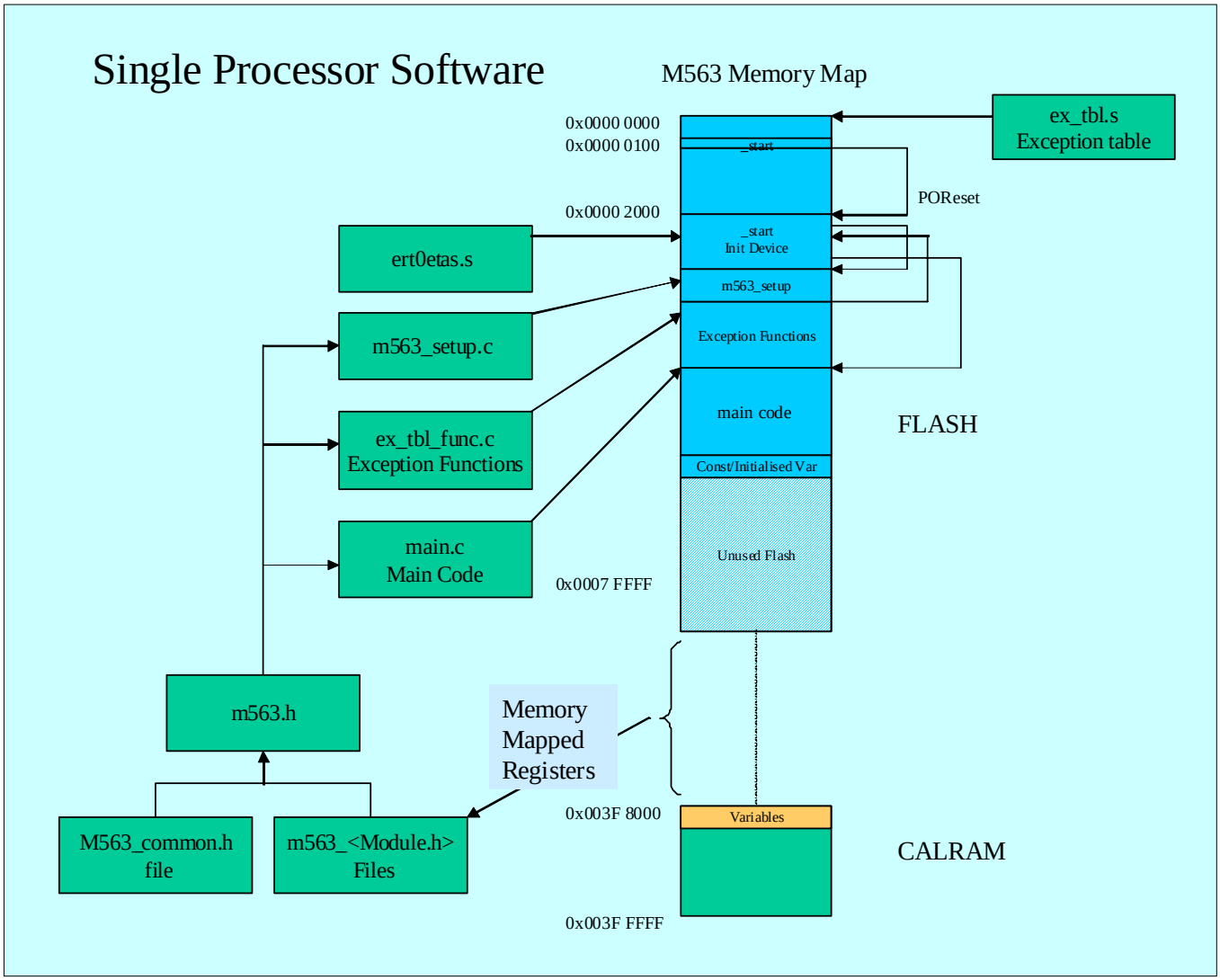

Figure 2

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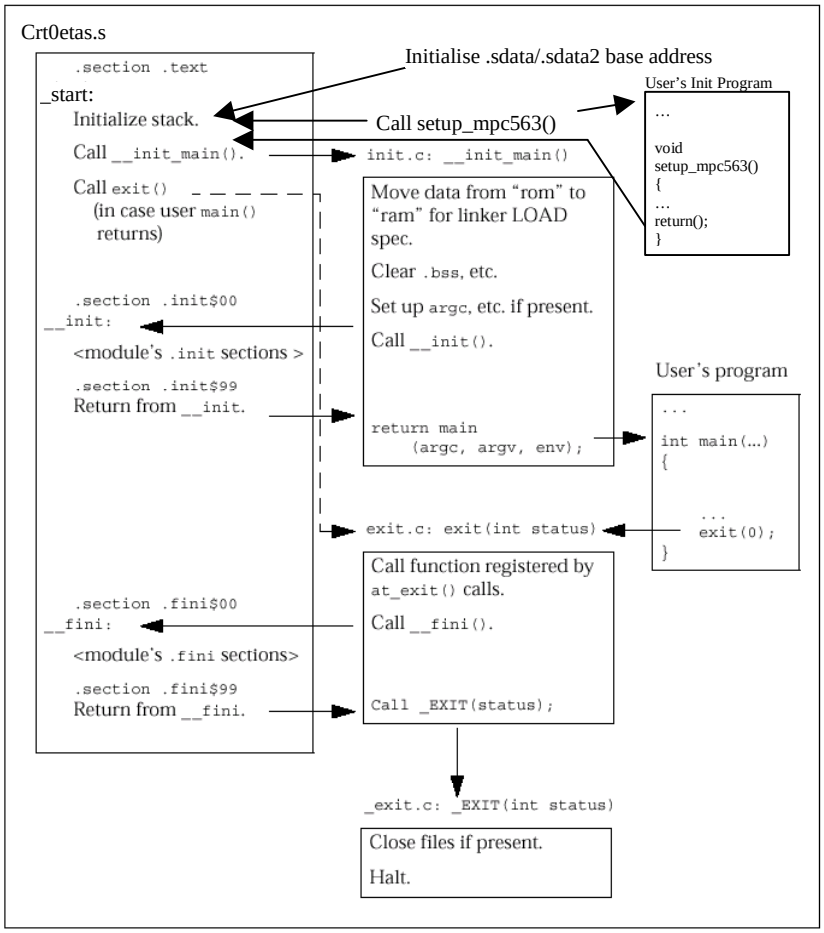
Header Files

The header files contain definitions for registers defined within the device for each module and are combined into a single device header file mpc563.h. These are defined as structures that allow register, bit-group or bit-wise access. There is an additional m563_common.h header file that holds global module definitions.

crt0.s

The crt0.s file is an assembler file that initialises the device.
The function _start is defined as the address to run at boot-up, which is called from the reset vector by the branch absolute _start instruction.
The following diagram show the startup and termination control of the crt0.s file.



This file performs the standard DIAB crt0 actions. It is important to understand the sequence for the single processor as this file needs to be modified for the dual processor software. The following describes the operations in this file:

1. Initialize stack: Loads Register1 with the Stack Pointer
2. Loads Register13 with the SDA (Small Data Area) base address. Global or static variables are accessed relative to the base address with a 16bit offset.
3. Loads Register2 with the SDA2 (Small Const Area) base address. Constant initialised/uninitialised variables are accessed relative to the base address with a 16bit offset.

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4. Calls the setup_mpc563 function in mpc563.c, which configures the device.
5. The file then calls __init_main function to initialize local variables which then calls the users main() function. The main function in the demo code never returns.

mpc563.c

The setup_mpc563 function call from the crt0.s file configures the device:

1. Disables the watchdog timer.
2. Sets the system clock frequency to 56MHz.
3. Disables the time base decrementor hardware.
4. Sets the IMB bus to run at full system clock frequency.
5. And finally configures the core special purpose registers.

Note

If you only use MPC563 internal flash memory as storage you should not enable BBC burst in the dual processor system. A master cannot burst internally when connected to a slave device.

ex_tbl.s and ex_funcs.c

The assembler file ex_tbl.s uses the .org command to setup function calls for the exception table at 0x100 byte intervals. The NMI/Reset (System Boot) function at address location 0x100 calls the _start function. The branch instructions for all other interrupts are defined in the ex_funcs.c file.

The exception functions in the ex_funcs.c file places the device into an endless loop should an exception occur. This allows exceptions to be trapped. Alternatively the user may define their exception handler functions in this file.

main.c

The main.c file contains the main code for the processor to run. The main code is the top level user specific code.

makefile

This file defines the files to be compiled, assembled and linked to generate a .ELF file that can be downloaded into FLASH memory.

3.3. Dual Processor Software

For the dual processor configuration the master device stores the software in an unused area of flash that is relocated to the slave device during execution initialisation. This is shown in Figure 3.

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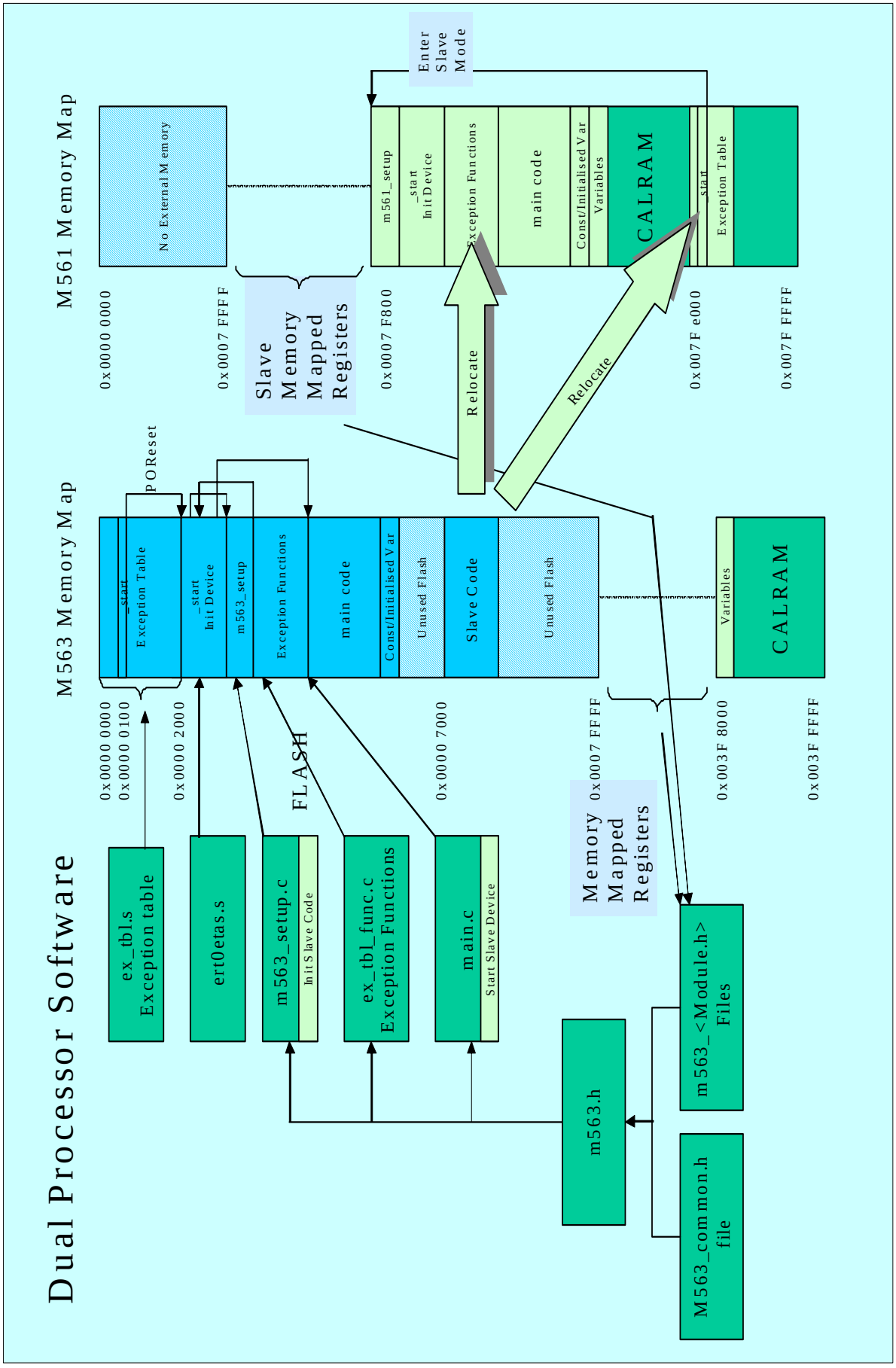

Figure 3

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m563_common.h

The base address for slave device is defined in the m563_common.h header file:

```
#ifndef INTERNAL_MEMORY_BASE
#define INTERNAL_MEMORY_BASE 0x00000000
#endif
#ifndef SLAVE_INTERNAL_MEMORY_BASE
#define SLAVE_INTERNAL_MEMORY_BASE 0x00400000
#endif
```

The RCW base address (IMMR[ISB0:2]) for both the master and slave MUST match the address defined in the m563_common.h file.

The header files were modified to define the slave hardware registers in addition to the master hardware registers. An examples is shown for definition of the slave UISU module:

```
struct USIU_tag *USIU = (struct USIU_tag *) (INTERNAL_MEMORY_BASE + 0x2FC000);
struct USIU_tag *SLAVE_USIU = (struct USIU_tag *) (SLAVE_INTERNAL_MEMORY_BASE +
0x2FC000));
```

crt0.s

The crt0.s file for the dual controller is the same as for the single processor, except that the function setup_mpc563 has been renamed to setup_master. And the file containing this function has been renamed from mpc563.c to setup_master.c file.

setup_master.c

This file is the same as the mpc563.c for the single processor development with some extended functions detailed below.

In the dual processor application the master device also configures the slave device with memory-mapped accesses. In addition to setting up the master device the code also performs the following:

1. Configures Master IO for Slave Reset control.
2. Waits for the master PLL to lock on set frequency.
3. Disables the slave device watchdog timer.
4. Sets up TSIZE to be driven by external data bus. Master/Slave mode requirement.
5. Retry function enabled. When an external master owns the bus and the internal bus on the slave initiates access to the external bus at the same time as the master, this signal is used to cause the external master to relinquish the bus for one clock to solve the contention. This is a Master/Slave mode requirement.
6. Sets IMB bus to run at system frequency as default is half the system frequency.

The following operations relocate code from the master internal FLASH memory to the slave CALRAM. The master internal FLASH memory address location and size and the slave CALRAM address are provided by user define variables defined in the linker file.

7. Copies the exception table to the slave CALRAM at - 8 -

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8. Copies the code to the slave CALRAM at address 0x07F8000.
9. Copies the data section to the slave CALRAM following the Code section. This contains DATA, CONST and STRING data types.

main.c

The main.c file contains the code to start the slave processor running.
The additional files required for the dual controller are depicted in Figure 4.

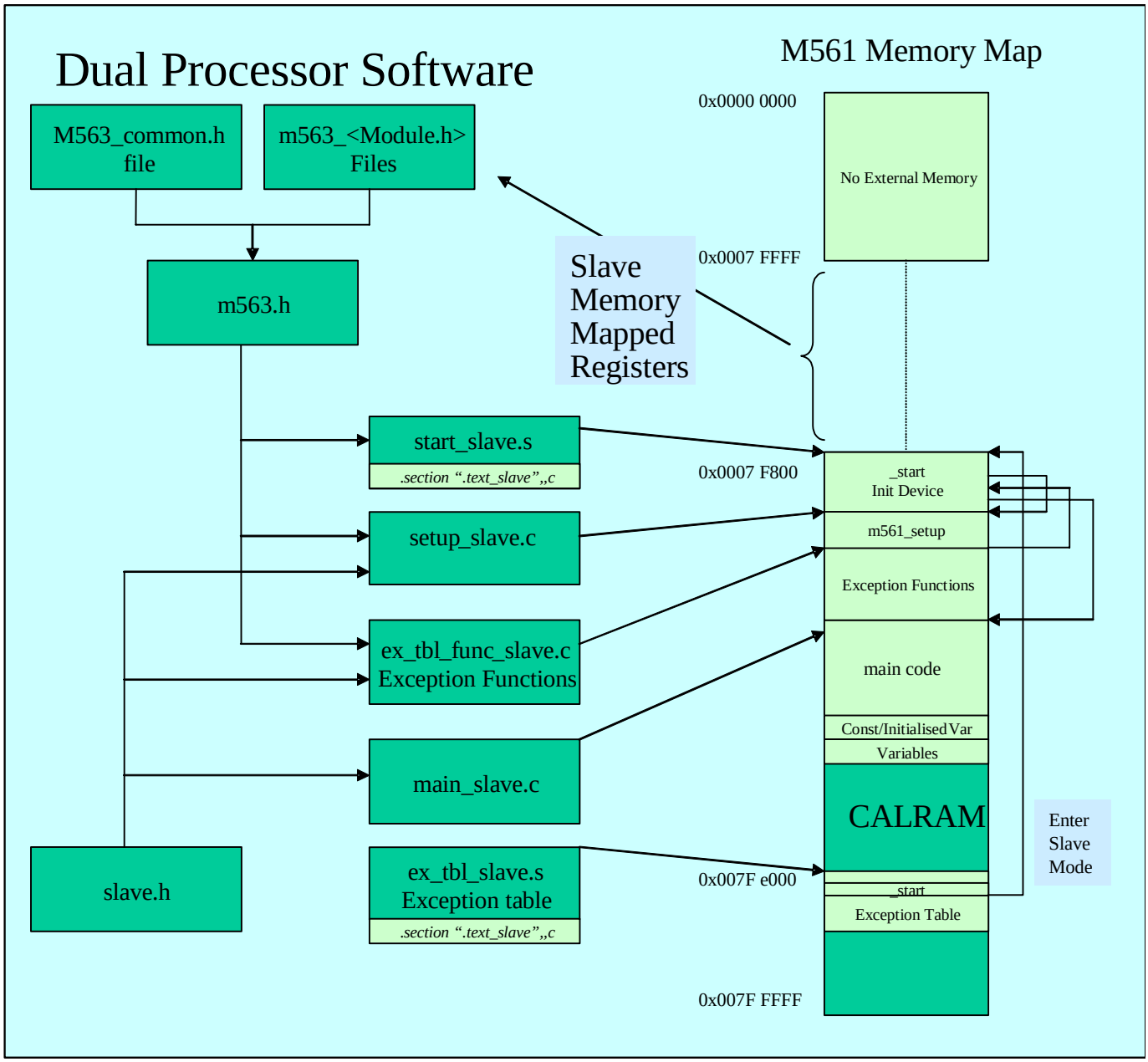

Figure 4

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slave.h
The slave.h file contains linker information that is used to partition the slave and master software. The default complier sections names are used to define sections for the master device and the user defines section names are used to define sections for the slave device

Section	Description	Section Names	
		Default	User Defined
CODE	code generated in functions	.text	.test_slave
DATA	static and global variables size in bytes > -Xsmall-data:	.data	.data_slave
SDATA	Variables, size in bytes <= -Xsmall-data:	.sdata/.sbss	.sdata_slave/ .sbbs_slave
CONST	const variables, size in bytes > -Xsmall-const:	.text	.text_slave
SCONST	const variables, size in bytes <= -Xsmall-const:	.sdata2	.sdata2_slave
STRING	string constants:	.text	.text_slave

Figure 5

The slave.h file is included into all .c files that are specific to the slave device. These files use pragma statements to section the code:

```
#pragma section CODE   ".text_slave"
#pragma section DATA   ".data_slave"
#pragma section SDATA  ".sdata_slave" ".sbss_slave"
#pragma section CONST  ".text_slave" ".text_slave"
#pragma section SCONST ".sdata2_slave" ".sdata2_slave"
#pragma section STRING ".data_slave"
```

Refer to Figure 5 and the Diab Users' Manual for further information.

The slave .s assembler files were modified directly with an explicit section command:

```
.section ".text_slave",,c
```

There is an option in linker to generate and combine sections together by using file names. However individual files have to be specified in the linker file as no method exists to use "wild-star" characters to identify files by type.

start_slave.c
The slave device does not use a crt0.s file. The slave device uses a file called start_slave.c. This file contains the _start_slave routine. This is the routine, called from the reset vector, to run the slave at boot-up.

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This file:

1. Loads Register1 with the Slave Stack Pointer.
2. Loads Register13 with the Slave SDA (Small Data Area) base address. Global or static variables are accessed relative to the base address with a 16bit offset. The base address is calculated by adding 0x7FF0 to the slave address of the small data area which is provided by the dual.dld linker file.

   This 0x7FF0 offset permits any variable in either section to accessed with a single instruction using a 16-bit offset from the r13 register. Note that this limits the combined size of the two sections to 64KB - 0x10 (the 0x10 facilitates certain optimizations). Refer to the Diab Tools Suite Users' Manual for more information.
3. Loads Register2 with the Slave SDA2 (Small Const Area) base address. Constant initialised/uninitialised variables are accessed relative to the base address with a 16bit offset. The base address is calculated by adding 0x7FF0 to the slave address of the small data area which is provided by the dual.dld linker file.
4. The file then calls the setup_slave function in setup_slave.c, which configures the device special purpose registers, non memory-mapped functions, which need to be executed by the slave.
5. Calls the main_slave function. The main_slave function in our demo code never returns.

setup_slave.c

Not all the setups required for the slave are memory mapped. The special purpose registers in the core need to be setup from the slave itself. This function is called during the slave startup.

ex_tbl_slave.s

This file contains the re-locatable exception table. This assembler file contains the branch absolute commands to the functions defined in ex_funcs_slave.c and the _start_slave function defined in the start_slave.c file.

This file was generated using an ".align 3" assembler directive to ensure an 8byte boundary for the branch calls. (Compressed code can use all 8bytes as instructions can be > 4bytes). This code can then be directly copied into the relocated exception table in the slave CALRAM at 0x7FE000. An alternative method would be to use the .word command to align the vector branch instructions.

NOTE

The use of the .org statement cannot be used to generate the vector table because the code has to be re-locatable.

ex_funcs_slave.c

The example exception functions in the ex_funcs_slave.c file place the device into an endless loop should an undefined exception occur in the slave device. The loop allows exception to be trapped. Alternatively the user may define their exception handler functions in this file.

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main_slave.c
The main_slave.c file contains the main code for the processor to run.

The makefile
This file defines the files to be compiled, assembled and linked to generate a .ELF file that can be downloaded into FLASH.

3.4. Dual Processor Software Compiler Options

The dual processor code is compiled with the following additional options:

- -Xpragma-section-last
  Normally the pragma section returns to the default section when a definition or declaration is seen in the compiled code. Setting the option -Xpragma-section-last allows prototype definitions or declarations within the *.c code, without reverting to the default pragma section. This allows the use of the “pragma section” statements to be defined once in the slave.h header file. Including this header into any slave code *.c file will automatically define to code in the slave section for the linker. Refer to Diab 4.4b release note for further information and slave.h description.
- -Xcode-relative-far-all
  Required for short variable definitions that are out-with the 64K offset boundary. This is used for variables that are relocated in the slave device which has a 0x400000 base address offset.

3.5. Dual Processor Linker File

The linker file, dual.dld, is used to generate the .ELF file by placing code and data into the appropriate memory mapped locations for both the master and the slave and resolving all addressing.
The linker file defines the memory map areas area:

```
MEMORY
{
        rom_vtbl:             org = 0x000000, len = 0x2000  /* Master Vector Table */
        rom:                  org = 0x002000, len = 0x5000  /* Master Flash - Master Code
*/
        ram:                  org = 0x3f8000, len = 0x2000  /* Master RAM */
        stack:                org = 0x3fa000, len = 0x5000  /* Master Stack */
        rom2:                 org = 0x007000, len = 0x5000  /* Master Flash - Slave Code
*/
        ram_vtbl_slave:       org = 0x7fe000, len = 0x2000  /* Slave Vector Table */
        ram_slave:            org = 0x7f8000, len = 0x4000  /* Slave RAM */
        stack_slave:          org = 0x7fc000, len = 0x2000  /* Slave Stack */
}
```

The linker file then extracts all slave code from the object files of the types defined with the section definitions. All default section code is considered to be master code.

The memory map in Figure 6 shows where the code sections will be located and user defined memory pointers.

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```
/* This block specifies where and how the linker should locate different
 * modules of the system.
 *
 * This example will allocate according to the following map:
 *
 * 0x0:         +-------------------------------+
 *              | Exception Routines            |
 * 0x2000       +-------------------------------+
 * "rom"        | Program code(1)               |
 *              | (2)                           |
 *              +-------------------------------+ <- __DATA_ROM
 *              | ROM Image of initialized data |
 *              | (3)                           |
 *              +-------------------------------+
 *              | (Unused portion of "rom")     |
 * 0x7000       +-------------------------------+ <- __VTBL_ROM_SLAVE
 * "rom2"       | Slave Exception Routines      |
 *              +-------------------------------+ <- __CODE_ROM_SLAVE
 *              | Slave Program code            |
 *              |                               |
 *              +-------------------------------+
 *              | ROM Image of Constants        |
 *              +-------------------------------+ <- __DATA_ROM_SLAVE
 *              | ROM Image of initialized      |
 *              | Slave data                    |
 *              +-------------------------------+
 *              | (Unused portion of "rom")     |
 *              +-------------------------------+
 *
 *                      Gap -- Not used
 *
 * 0x3f8000:    +-------------------------------+ <- __DATA_RAM
 * "ram"        | Memory reserved for           |
 *              | initialized data              |
 *              +-------------------------------+ <- __DATA_END, __BSS_START
 *              | Uninitialized data            |
 *              |                               |
 *              +-------------------------------+ <- __BSS_END, __HEAP_START
 *              | Memory reserved for the heap  |
 *              | (all unused "ram")            |
 * 0x3fa000:    +-------------------------------+ <- __HEAP_END (3) & __SP_END (3)
 * "stack"      | Memory reserved for the stack |
 *              | (all of the "stack")          |
 * 0x400000:    +-------------------------------+ <- __SP_INIT
 *
 *
 ********************************************************************************
 * SLAVE DEVICE
 ********************************************************************************
 * 0x7f8000     +-------------------------------+ <- __CODE_START_SLAVE
 * "ram"        | Slave Program code            |
 *              |                               |
 *              +-------------------------------+ <- __CODE_END_SLAVE,__DATA_RAM_SLAVE
 *              | Memory reserved for           |
 *              | initialized data              |
 *              +-------------------------------+ <- __DATA_END_SLAVE, __BSS_START_SLAVE
 *              | Uninitialized data            |
 *              |                               |
 *              +-------------------------------+ <- __BSS_END_SLAVE, __HEAP_START_SLAVE
 *              | Memory reserved for the heap  |
 *              | (all unused "ram")            |
 * 0x3fa000:    +-------------------------------+ <- __HEAP_END_SLAVE, __SP_END_SLAVE
 * "stack"      | Memory reserved for the stack |
 *              | (all of the "stack")          |
 * 0x3fe000:    +-------------------------------+ <- __SP_INIT_SLAVE,VTBL_START_SLAVE
 *              | Relocated Vector Table        |
 * 0x400000:    +-------------------------------+ <- VTBL_END_SLAVE
 ********************************************************************************
```

Figure 6

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The linker file uses the LOAD command to place all the slave sections into the virtual memory of the slave device. This is shown in Figure 6.

The slave vector table is stored in to the internal flash memory of the master device at address 0x7000(rom2) and loaded into the virtual (run time) address 0x7FE000 (ram_vtbl_slave) of the slave CALRAM.

```
.text_vtbl_slave (TEXT) LOAD(ADDR(rom2)) :
                                { ex_tbl_slave.o(.text_slave) } > ram_vtbl_slave
```

The CODE and DATA sections are stored in the master device internal flash memory following the slave vector table and loaded into the virtual(run time) address 0x7F8000 (ram_slave) of the slave CALRAM. The syntax *(.<type>) identifies all files in the current directory where the code <type> matches. The data types are defined in Figure 5.

```
GROUP : {
   .text_slave (TEXT) LOAD(ADDR(rom2)+SIZEOF(.text_vtbl_slave)):
   {
     *(.text_slave)
   }
```

These link commands select the CODE section at the rom2(slave code) address in the master device offset by the size of the VECTOR TABLE. Refer to block description above.

```
   .sdata2_slave (TEXT) LOAD(ADDR(.text_slave)+SIZEOF(.text_slave)):
   {
     *(.sdata2_slave)
   }
```

These link commands select the SCONT section at the rom2(slave code) address in the master device offset by the size of the VECTOR TABLE and CODE.

```
   /* This will reserve space for the .data in the beginning
   * of "ram" but actually place the image at the end of
   * .text segment
   */
   .data_slave (DATA) LOAD(ADDR(.sdata2_slave)+SIZEOF(.sdata2_slave)) :
   {
     *(.data_slave)
   }
```

These link commands select the DATA section at the rom2(slave code) address in the master device offset by the size of the VECTOR TABLE, CODE and SCONT.

```
   /* .sdata contains small address data */
   .sdata_slave (DATA) LOAD(ADDR(.data_slave)+SIZEOF(.data_slave)) :
   {
     *(.sdata_slave)
   }
```

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These link commands select the .SDATA section at the rom2(slave code) address in the master device offset by the size of the VECTOR TABLE, CODE, SCONT and DATA

```
        /* This will allocate the .bss symbols */
                                                /* LOAD command not need for un-initialised
variables codes initialises RAM to 0x00 */
        .sbss_slave (BSS)       :
        {
          *(.sbss_slave)
        }
        .bss_slave  (BSS)       :
        {
          *(.bss_slave)
        }
```

These link commands select the .SBSS and .BSS un-initialised variables section at the rom2(slave code) address in the master device offset by the size of the VECTOR TABLE, CODE, SCONT, DATA and SDATA.

```
            /* Any space left over will be used as a heap */
    } > ram_slave
```

Place all CODE and DATA identified above into the virtual address of the slave CALRAM defined by ram_slave.

The remaining sections defined in the object files are placed into the master device.

```
    GROUP : {
            .text (TEXT)   : {
                    *(.text) *(.rodata) *(.rdata) *(.init) *(.fini)
            }
            /* Next take all small CONST data */
            .sdata2 (TEXT) : {}
    } > rom

    /* The second section will allocate space for the initialized data
     * (.data/.sdata) and the unititialized data (.bss/.sbss) in the "ram" section.
     *
     * Initialized data is actually put at the end of the .text section
     * with the LOAD command. The function __init_main() moves the
     * initialized data from ROM to RAM.
     */
    GROUP : {
            /* This will reserve space for the .data in the beginning
             * of "ram" but actually place the image at the end of
             * .text segment
             */
            .data (DATA) LOAD(ADDR(.sdata2)+SIZEOF(.sdata2)) : {}
            /* .sdata contains small address data */
            .sdata (DATA) LOAD(ADDR(.sdata2)+SIZEOF(.sdata2)+SIZEOF(.data)) : {}

            /* This will allocate the .bss symbols */
            .sbss (BSS)        : {}
            .bss  (BSS)        : {}

            /* Any space left over will be used as a heap */
    } >ram
```

The linker also sets up memory pointers based on the size and location of the sections. These pointers are used in the object files to setup:

1. Master and Slave Stack Pointers
2. Base Address Locations for Slave short data sections
3. Slave relocation routines for code, data and Exception Table.

4. Library Functions

Common functions MUST be defined ONLY once for the dual processor application, otherwise the complier generates a function redefinition error.

To resolve this on the dual controller board the hardware needs to be configured to allow both processors to access the same executable code. In the current configuration the Master device can access the internal address space of the Slave device however the

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Slave device has no access to the internal address space of the Master device as this is configured for master mode.

Configuring the Master device in a slave configuration allows the Slave device to access the internal address space of the Master device.

This method is very inefficient from a performance point of view. For performance critical functions separate functions should be defined for the slave and master device.

Refer to Section 7 of *Multi-controller Hardware Development for MPC5xx Family*, AN2667.

This is accomplished by setting SLVM bit in the EMCR register from the Master device code.

```
//*****************************************************************************
// Function     : master_to_slave_mode
// Description  : switches MASTER Device from MSTR to SLVM mode.
// Parameters   : none
// Returns      : none
// *****************************************************************************
void master_to_slave_mode()
{
        USIU.EMCR.B.SLVM = 0x1;
}
```

In addition to configuring the Master device to slave mode, the BDIS bit is also set to ensure the memory controller on the slave device is not active after reset. This is accomplished by setting the DBIS bit on the data bus reset configuration word (RCW) (D4 = 0x1).

Slave inter communication with the master does NOT require chip select. On system boot the slave code is run from its internal CALRAM.

The example code was modified to use the Slave device to call an external function defined in the internal flash memory of the master device. This function was used switch an LED on and off by accessing the master PortQA pin PQA7.

This function subsequently called an external function on the slave to delay the turn on-off time of the LED.

The Slave device used a similar function to call its own local function to flash the slave LED on PortQA pin PQA7.

Slave Code:

External definition:

```
// *** External function prototype definitions ************************
extern void flash_master_led();
```

Slave device main function:

```
void main_slave(void)
{
  // Function to Flash Slave LED
  SLAVE_QADC_A.DDRQA.B.DDQA7 = 1;   /* setup QADC A port A7 as output */
  while(1){
    SLAVE_QADC_A.PORTQA.B.PQA7 = 0;
    delay(100);
    SLAVE_QADC_A.PORTQA.B.PQA7 = 1;
    delay(100);
    flash_master_led();
  }
}
```

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Master Code:

External definition:

```
// *** External function prototype definitions ************************
extern void delay(UINT8);
```

Master Device function:

```
void flash_master_led()
{
  // Function to Flash Slave LED
  QADC_A.DDRQA.B.DDQA7 = 1;   /* setup QADC A port A7 as output */
  QADC_A.PORTQA.B.PQA7 = 0;
  delay(100);
  QADC_A.PORTQA.B.PQA7 = 1;
  delay(100);
}
```

5. Limitations

The Diab compiler/linker used for the code compilation has a limitation with global variable assignments definitions for the slave device. The compiler/linker allocates memory location but does not initialize the contents.

That is,

```
// *** Global Variable Definition ***********************************
UINT32 delay_value = 0x0007FFFF;
```

The work around for global variables assignments is to assign the global variable at run time.

That is,

```
 // *** Global Variable Definition ***********************************
UINT32 delay_value;

void init_gvars(void)
{
  delay_value = 0x0007FFFF;
}
```

Local function global variables assignments are not affected.

6. Conclusion

This application note demonstrates one method in developing code for a dual master and slave device using the linker to relocate the code from the master device to the slave device. This method allows simple generation of dual processor code that shares common library functions. For increased performance common functions can be defined by the user for each processor. The proposed method minimises code depth but with performance trade offs.

Alternative methods are available that include writing separate code for the master and slave. A runtime loader would need to be developed for the master device to relocate a separately generated s-record into the slave at startup. This method would minimise inter-processor communication but maximise code size.

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